User Guide

MAXAX

Variable Speed Drive
for brushless AC servo motors
1kW to 3kW

Part Number 0436 - 0702
Issue Number 4

⚠ Safety Information

Persons supervising and performing the electrical installation or maintenance of a Drive and/or its external Option Unit must be suitably qualified and competent in these duties. They should be given the opportunity to study and if necessary to discuss this User Guide before work is started.

The voltages present in the Drive and external Option Units are capable of inflicting a severe electric shock and may be lethal. The Stop function of the Drive does not remove dangerous voltages from the terminals of the Drive and external Option Unit. AC power should be removed before any servicing work is performed.

The installation instructions should be adhered to. Any questions or doubt should be referred to the supplier of the equipment. It is the responsibility of the owner or user to ensure that the installation of the Drive and external Option Unit, and the way in which they are operated and maintained complies with the requirements of the Health and Safety at Work Act in the United Kingdom and applicable legislation and regulations and codes of practice in the UK or elsewhere.

The Drive software may incorporate an optional Auto-start facility. In order to prevent the risk of injury to personnel working on or near the motor or its driven equipment and to prevent potential damage to equipment, users and operators, all necessary precautions must be taken if operating the Drive in this mode.

The Stop and Start inputs of the Drive should not be relied upon to ensure safety of personnel. If a safety hazard could exist from unexpected starting of the Drive, an interlock should be installed to prevent the motor being inadvertently started.

General Information

The manufacturer accepts no liability for any consequences resulting from inappropriate, negligent or incorrect installation or adjustment of the optional operating parameters of the equipment or from mismatching the Drive with the motor.

The contents of this User Guide are believed to be correct at the time of printing. In the interests of a commitment to a policy of continuous development and improvement, the manufacturer reserves the right to change the specification of the product or its performance, or the contents of the User Guide, without notice.

Part Number: 0436–0702
Issue Code MXNU4

Contents

1 Introduction

MaxAx is a Variable Speed Drive that controls permanent-magnet brushless motors. Three versions of the Drive cover a range of power ratings.

Power circuits

The Drive takes power from nominal 220V three-phase bus which can be obtained directly or through an isolating transformer. The Drive can be powered from a single-phase supply if a derating factor is acceptable.

The output of the Drive is connected to a motor and its resolver. The output is controlled by a IGBT power bridge.

An internal braking resistor dissipates motor energy during regeneration.

To simplify wiring (especially useful in multi-axis applications) power and signal connectors are located on the front panel.

Signal circuits

In addition to the signal connectors on the front panel, a connector on the bottom of the Drive allows connection to back-up encoder simulation circuits.

The signal circuits are opto-isolated from the power circuits.

Daughter boards

A removable Personality daughter board allows the Drive to be quickly personalized to meet individual requirements. There are two types of daughter board:

- Basic Personality daughter board
- Options Personality daughter board

Multi-turn trimmers on the daughter boards are used to adjust the following:

- Proportional gain
- Derivative gain
- Acceleration/deceleration ramp gradient (for max speed)
- Speed reference offset
- Full scale speed

The trimmers are accessible from the front panel.

DIP switches on the daughter boards are used to adjust the following:

- Nominal Drive current
- Rated motor speed
- Number of motor poles (2, 4, 6 or 8).
- Simulated encoder resolution
- Speed scale
- Enable limit switches

On the Options daughter board are functions for managing the following:

- Limit switches
- Encoder simulation

These are used when the Drive is connected to a positioning controller.

By transferring the daughter board, it is possible to quickly equip a replacement Drive with the same personality as a Drive that has been removed.

2 Functional description

Two high-performance control loops are used to control the motor speed and torque.

Motor speed is compared with an analogue **Speed Reference** signal from an external controller. The speed error signal is processed by a PID (Proportional, Integral and Derivative) filter to stabilise a velocity loop. The output of this filter is the **Current Reference** signal which can vary between –10V and +10V. When the signal is at the positive or negative limit, the Drive delivers maximum current.

A speed feedback signal is simulated by the Drive using position information from a resolver mounted on the motor shaft.

The nominal current of the Drive may be programmed by setting DIP switches in switch bank SW2. If maximum current is demanded for more than 2 ±0.5 seconds, a current limiting circuit reduces the **Current Reference** signal to the value programmed using DIP switches SW2.

A **Current Error** signal is produced by comparing the output of the current limiting circuit with the actual motor current (measured internally). The **Current Error** signal is used to generate PWM signals that control the IGBT bridge.

When the Drive is in $\mathbf{I^2t}$ limit, a red **HIGH Irms** LED lights and pin 12 of the signal connector becomes open circuit.

A diagnostic function protects the Drive against faulty or incorrect connections. Some faults such as Overvoltage, Under-voltage and Over-temperature are reset when the fault is cleared. Other faults such as a short-circuit between connector pins or an encoder break require the Drive to be reset by powering it down for at least 10 seconds.

For more detailed information see Diagnostics.

3 Data

Analogue reference input

±10V (10 kΩ input impedance)

Error amplifier temperature drift

1.3µV/°C (1.8µV/°F)

Control range with 10V reference

14-bit 3000 rpm —
300µV sensitivity

12-bit 6000 rpm with hardware modification — 1mV sensitivity

Linearity

0.15% in relation to full scale

Reversion error

0.5% in relation to the full scale

Working temperature

−10°C to +50°C (−40°F to +147°F)

Output current ratings

	MaxAx 100	MaxAx 200	MaxAx 300
Maximum current (rms)	8.4	14.0	21.2
Nominal current (rms)	4.2	7.0	10.6

Supply voltage

220Vrms +20% −15% (no load)

Max voltage between phases at the motor

Supply Voltage less 10V

Current tolerance

±10% referred to peak current

Internal braking resistor

33Ω 150W

Over-temperature limit

95°C (203°F) at the heatsink

Under-voltage limit

130VDC on the DC bus

Over-voltage limit

416VDC on the DC bus

Braking circuit

The braking circuit is automatically disabled when the three-phase supply is lost and the DC bus voltage is not zero.

4 Signal and power connections

Signal connector

Pin No.	Function	I/O	Notes
1	Tacho	Out	
Simulated tacho output signal derived from the resolver. −10V to +10V for a full scale of 3000 or 6000 RPM selected using SW1/1.			
2	TPRC	In/Out	
TPRC (Test Point Requested Current) is a DC output signal in the range −10V to +10V proportional to the requested current value. When TPRC is at +10V or −10V, the Drive generates peak current. This pin can instead be used as **Current Reference** signal input (negative for CW rotation, positive for CCW rotation).			
3	Common		Signal common
4	Enable	In	
Drive enable signal (33kΩ input impedance) 10V to 30VDC = drive enable 0V or open-circuit = drive disable If the Drive is enabled when the reference signal is not zero, the motor starts at the required speed without following the programmed ramps. It is good practice to disable the Drive before removing power and to delay enabling the Drive applying power. These precautions will ensure stable operation of the Drive.			
5	+10V	Out	Voltage reference output +10 V (max 10mA)
6	−10V	Out	Voltage reference output −10V (max 10mA)
7	Speed reference non-inverting input	In	Non-inverting input for the speed reference signal
8	Speed reference inverting input	In	Inverting input for the speed reference signal
9	Drive status (Drive OK)	Out	
10	Drive status (Drive OK)	Out	
Pins 9 and 10 are internally connected when the green LED lights and the Drive is running. When a fault is detected internally, the contact is open. The contact rating is 1A 30Vdc.			

11	Common		Signal common
12	I^2t	Out	
Open collector transistor output normally on (0V). When the red I^2t LED lights during current limiting, this pin becomes open circuit. Maximum output ratings: 100mA, 47V.			
13	Common		Signal common
14	Motor PTC	In	
Connected to a thermal sensor on the motor. Link to pin 13 if not used (default). If −10V is applied, the Drive enters the Resolver Phasing mode. (See Re-phasing a resolver)			

Resolver connector

The resolver connector has two differential inputs and one differential output. All differential lines must be isolated from ground.

Pin No.	Connection	I/O	Function
15	Shield	Resolver cable shield	
16	Cosine low	In	Cosine low signal from resolver
17	Cosine high	In	Cosine high signal from resolver
18	Sine low	In	Sine low signal from resolver
19	Sine high	In	Sine high signal from resolver
20	Excitation low	Out	Excitation low signal to resolver
21	Excitation high	Out	Excitation high signal to resolver

Power connector

Pin No.	Connection	I/O	Function
22	E	Motor chassis ground	
23	Motor phase U	Out	
24	Motor phase V	Out	
25	Motor phase W	Out	
26	–DC	Out	–DC bus
27	+DC	Out	+DC bus
28	Internal braking resistor	Connect directly to pin 27 to connect the internal braking resistor (default connection)	
29	External braking resistor	Connect to external braking resistor (Connect other side of braking resistor to pin 27)	
30	Phase 1 (R)	In	
Phase 1 of the supply transformer secondary			
31	Phase 2 (S)	In	
Phase 2 of the supply transformer secondary			
32	Phase 3 (T)	In	
Phase 3 of the supply transformer secondary			
33	E		
Chassis ground power supply side			

Simulated Encoder connector

Pin No.	Description
34	Common
35	Direction +15V = CW 0V = CCW
36	Frequency output 0V to +15V
37	not A
38	A
39	not B
40	B
41	not C
42	C

Note

Frequency Output (pin 36) is factory set at 2048 pulses/revolution.

To modify the resolution, see Special Applications.

Limit Switches connector

Pin No.	Function
43	Limit switch CCW
44	Common
45	Limit switch CW
46	Common

During normal operation (limit switches enabled), pins 43 and 45 must be connected to +10V (pin 5).

By setting switches SW5 on the daughter board, the need for an external voltage source can be avoided. Refer to Configuring the Drive.
When a limit switch stops or starts the Drive, a fast ramp is applied; the ramp control is ignored.

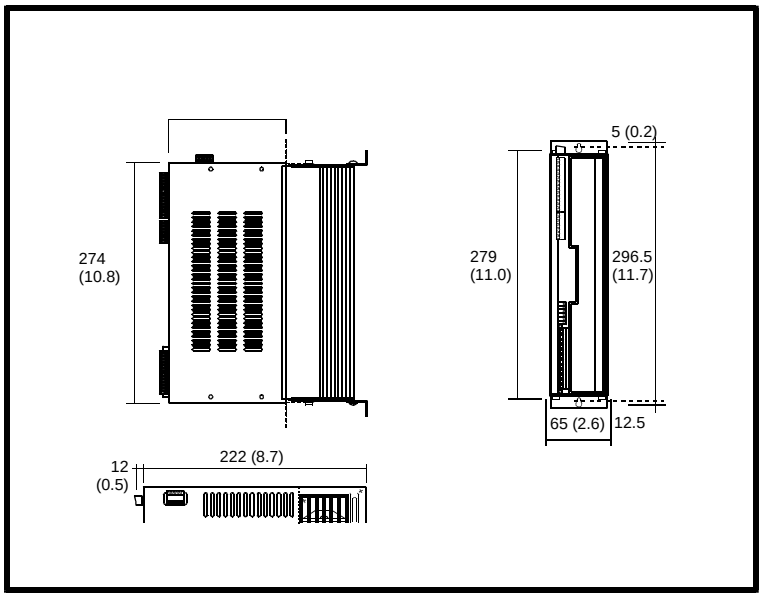
5 Installation

Mounting location

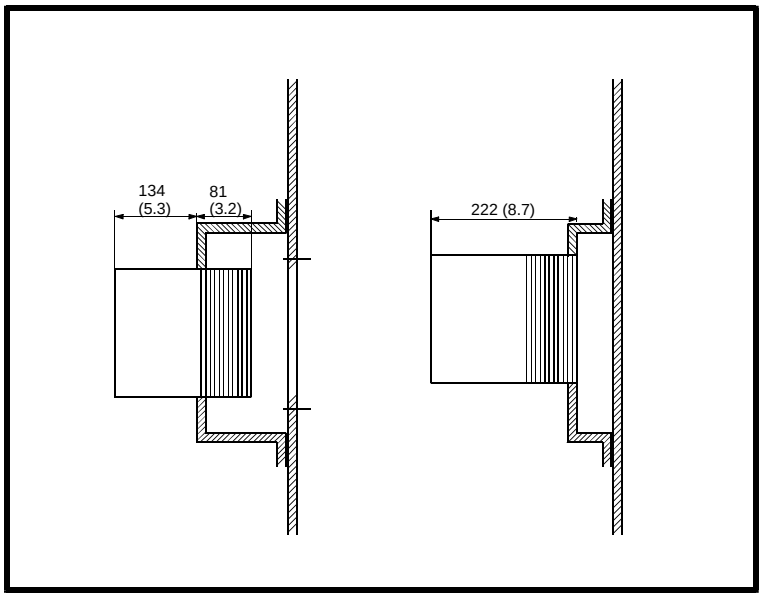
Locate the Drive in a place free from dust, corrosive vapours, gases and all liquids. The Drive may be mounted

- On an open panel
- Inside an enclosure

(The heatsink may project through the mounting panel into a free air space behind.)
Use the two mounting brackets supplied with the Drive for either of the two alternative mounting arrangements. Each mounting bracket is attached to the heatsink by two self tapping screw. Install the Drive vertically to ensure the best air flow through the cooling fins of the heatsink. To prevent over-heating, do not install the Drive vertically above other Drives or any heat producing equipment.
Note that the total power dissipated by the Drive, transformer and braking resistor is about 12% of the motor power. The Drive is disabled if the temperature of the heatsink reaches 95°C (203°F).



Mechanical details



6 Electrical Installation

Wiring

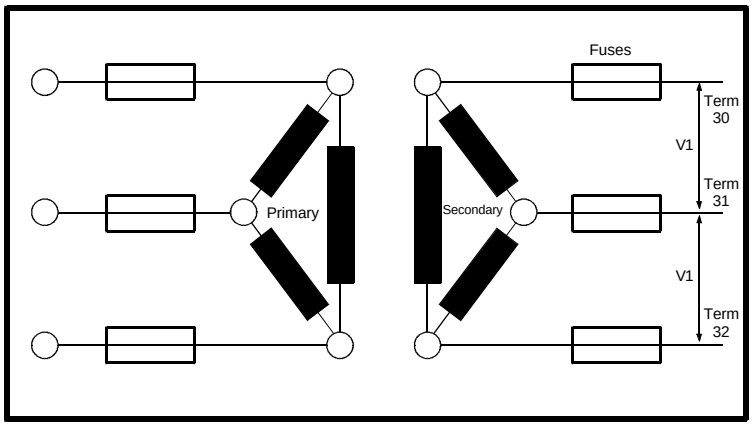
To minimise the effects of noise, signal cables must be segregated from power cables and routed in different ducts.

The recommended cross-section for signal cables is 0.5 mm^2 (AWG20).

The recommended cross-section for power cables is 2.5 mm^2 (AWG14).

Power supply

One three-phase transformer may be able to supply a number of Drives. The secondary must be delta connected (this is not essential for the primary). The rating of the secondary should not be less than the sum of the nominal power ratings of the connected motors. (Control Techniques is able to supply transformers for MaxAx Drives.)



Power supply circuit

Transformer rating

Use the following formula:

For each secondary winding the power in VA is:

$$\mathbf{Ps = (Paz * 15)} * \frac{\mathbf{173}}{\sqrt{\mathbf{(n+2)}}}$$

where:

Paz =
(Vm1*Cm1 + Vm2* Cm2 +...
+ Vmn*Cmn)

Vm = motor max speed in rad/sec = rpm/9.55

Cm = nominal motor torque in Nm

$1.73 / \sqrt{(n+2)}$ = corrective factor to be used for more than one Drive supplied in parallel

n = number of Drives

The overall transformer power in VA is:

Pt = Ps1 + Ps2 + ... + Psn

where:

Ps1 = power rating of secondary 1
Ps2 = power rating of secondary 2
Psn = power rating of secondary n

Cable size

Use 2.5 mm^2 (AWG14) wire to connect the Drive to the motor.

If the motor phase sequence is not known, see Re-phasing a resolver.

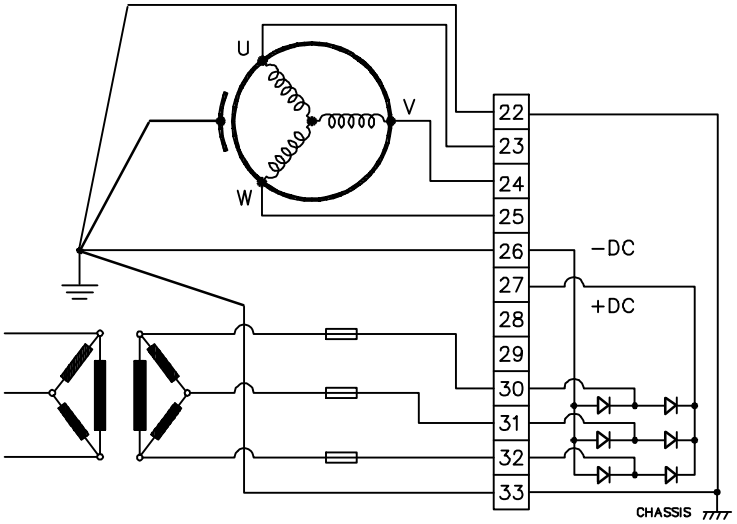
Fuses

Fit a fuse in each transformer secondary phase. The current rating of these fuses should be:

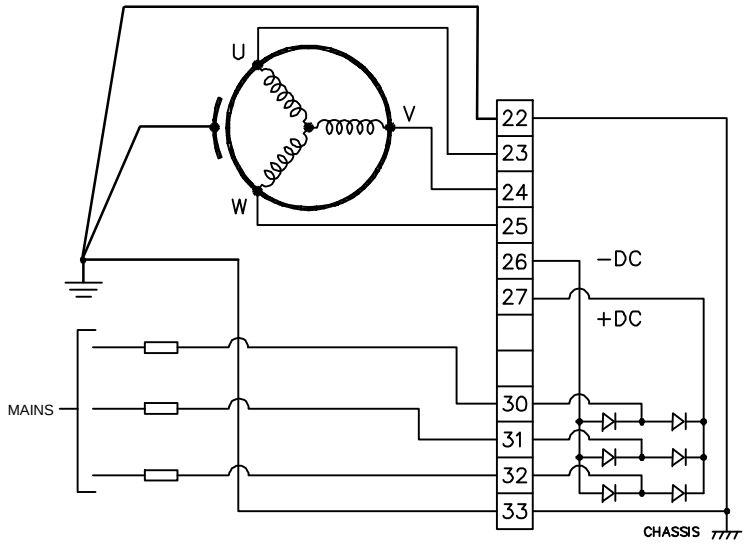
1.5 * Nominal current of the Drive

Typical fuse ratings are as follows:

Model	Rating
100	6 A
200	12 A
300	16 A



Drive supplied through a transformer



Drive supplied directly from the AC power

If more than one Drive is connected to the same secondary winding, it is necessary to fit a set of three fuses for each Drive.

Grounding

Warning

For safety, connect pin 22 and pin 33 to the enclosure ground bar. Ground connections can be made to the upper and lower mounting feet.

The –DC bus (pin 26) from each Drive must be connected to the grounding bar only when the Drive is supplied by an isolating delta wound transformer.

To prevent a Drive in a multi-axis system from inadvertently tripping, one common ground point must be used for the signal common and power common connection of all the Drives in the system. It is possible to use a suitably-sized grounding bar and mount it very close to the Drives.

A copper bar having a thickness of 5mm (0.2in) to 6mm (0.25in) and a width of 20mm (0.8in) may be used. The bar must be mounted on insulated supports.

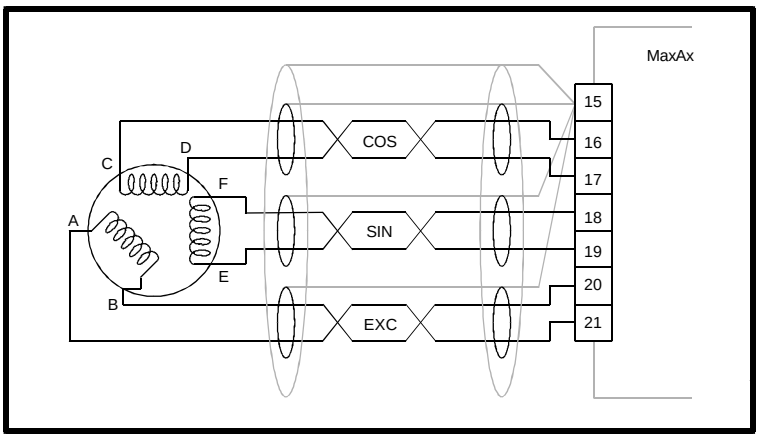
Connect each motor chassis ground to the grounding bar using a suitably sized cable.

Resolver connections

Connect the resolver using 0.22mm (0.085in) twisted-pair cable having three shields including a global shield.

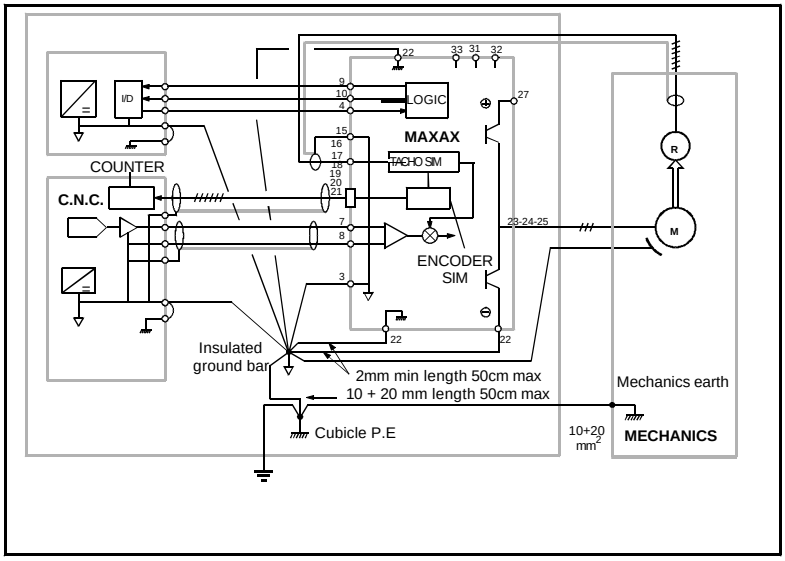
No adjustment is required for cable length up to 50 to 60metres (165 to 200 feet).

Refer to the specific motor documentation and refer to Re-phasing a resolver for mechanical phasing of the resolver

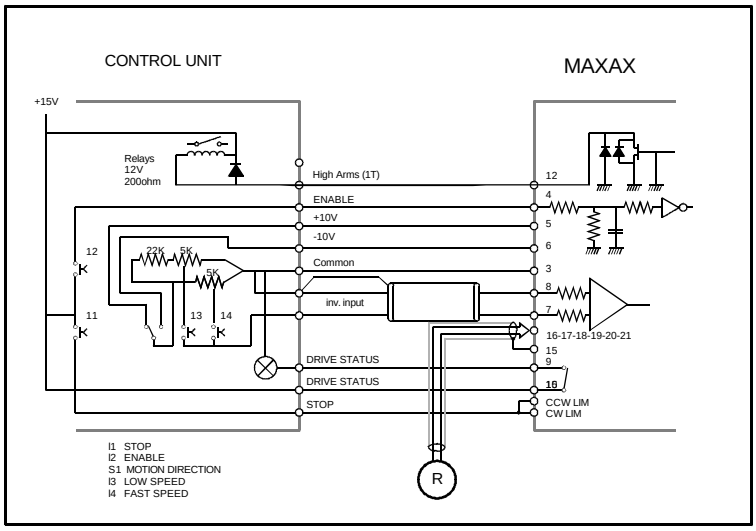


The letters represent the terminals of the DutymAx motor resolver connector

Typical motor resolver connections



Typical system connections



Typical control connections

7 Commissioning

Preliminary checks

1. Check that all the terminal block screws on the Drive signal connector are fully tightened.
2. Taking particular care, check the three cables from:
   - Transformer secondary winding
   - Motor
   - Resolver
3. Refer to How to recognize the motor phases to check the correct motor phase sequence.
4. Extract the **Personality** daughter board and check the positions of the DIP switches are correct.
5. Taking care not to disturb the DIP switch settings, replace the daughter board.
6. Refer to Start-up below. If necessary, also refer to Fault finding.

Start-up

Note

If a Drive does not behave as described during Start-up refer to Fault finding.

1. Disconnect the signal connector.
2. If you need to start a multi-axis system, remove the power supply fuses that serve all the Drives except for the one to be tested.
3. Apply power to the Drive. Check the green LED on the connected Drive illuminates after a 0.5 second delay.

4. Check that the following conditions are met:
   - The motor shaft is not driven but can be rotated by external means
   - There is no current flow in the motor
   - The green LED is continuously illuminated
5. Remove power from the Drive.
6. Repeat steps 1 to 5 for each of the remaining Drives in a multi-axis system.
7. Check that the speed reference output signal of the control unit is at 0V.
8. Connect the signal connector to the first Drive.

Warning

During the following steps, the load must be disconnected. The operator should be able to quickly switch off the system in an emergency.

9. Apply power to the Drive and check the Drive does not run.
10. Enable the Drive. Check the motor does not rotate or rotates slowly as a result of a defined signal offset.
11. Reverse the polarity of the reference signal to check the motor runs in either direction.
12. If the motor rotates in the opposite direction to that expected, check the connections of the resolver, motor and reference wires.
13. Repeat steps 7 to 12 for each Drive in a multi-axis system.
14. Refer to Calibration below.

Calibration

Adjustments and calibration are made using DIP switches and multi-turn trimmers on the daughter board.

Note

DIP switches are set at OFF when the slide is toward the connector on the front edge of the daughter board.

If the range of trimmer adjustment is found to be inadequate, refer to Range Components below.

MaxAx Drives are supplied with factory default calibration. To modify this calibration, the following equipment is required:

- Low-frequency function generator with an output level up to ±3.5V
- Twin-trace storage oscilloscope

Procedure

1. Remove the **Speed Reference** input from pins 7 and 8 of the signal connector and connect the function generator. Set the function generator as follows:

   Square-wave
   Amplitude: ±2V
   Frequency: 0.2Hz

2. Connect oscilloscope Channel A to Pin 1 of the signal connector (simulated tacho signal).

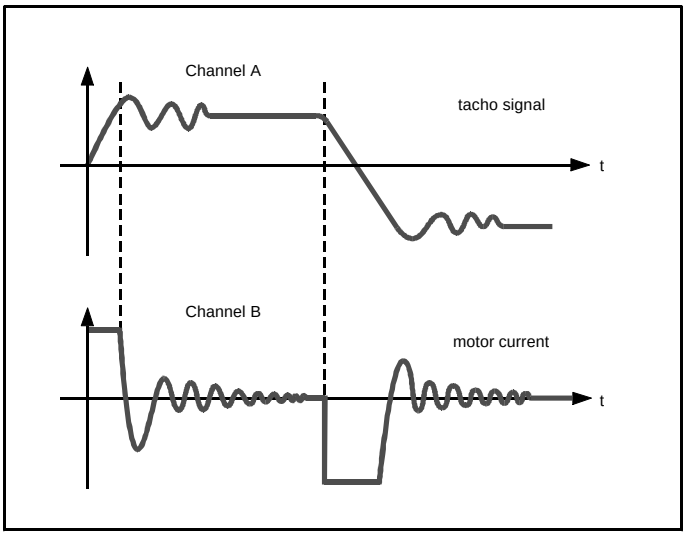
3. Connect oscilloscope Channel B to pin 2 of the signal connector (current demand).

4. Connect the oscilloscope ground to pin 11 of the signal connector.

5. Connect the oscilloscope external trigger input to the function generator output.

6. Set the oscilloscope as follows:

   Sensitivity: 1V / division
   Timebase: 20 ms / division
   The waveforms may appear as shown in the example in Fig. A. (In this case the system has insufficient dynamic gain).



Note

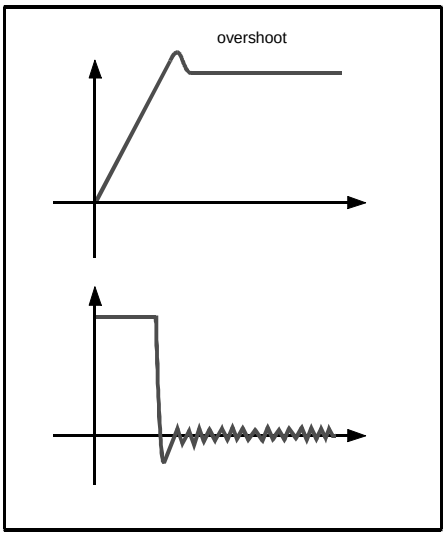
If the motor drives a slide that has a limited travel, prevent the limit switches operating by increasing the frequency or reducing the amplitude of the frequency reference signal.

The minimum acceptable amplitude of the frequency reference signal is 1V.

---

7. To eliminate overshoot, turn the **DERIVATIVE** trimmer clockwise. This increases derivative control (See Fig. B).

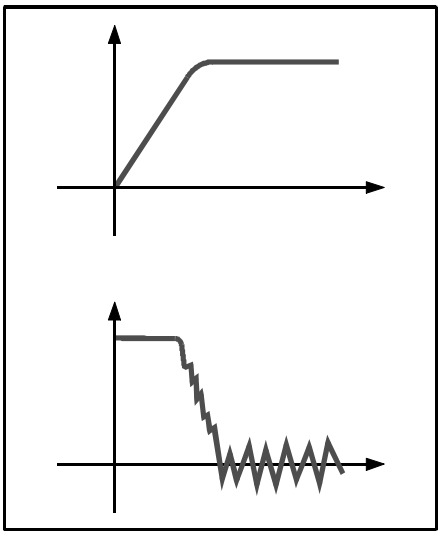
In most cases, it is acceptable to have a small amount of overshoot.



Note

If Derivative control is set excessively high, the time taken to reach the required speed is increased.

8. To eliminate oscillation, turn the **PROPORTIONAL** trimmer clockwise. This increases proportional control. See Fig. C.

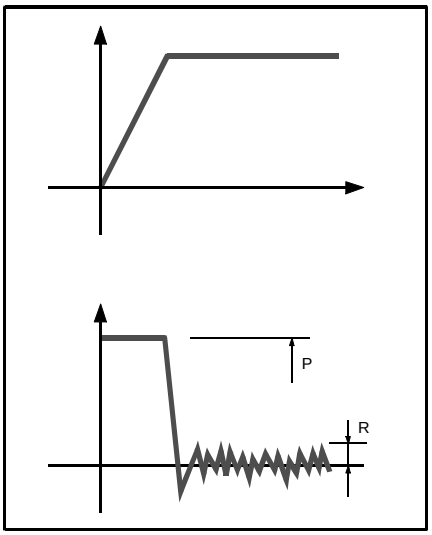


Note

An excessively high dynamic gain could introduce current noise

Current noise contributes to motor heating and may cause **I•t** current trips. See Fig. D.

An acceptable noise amplitude (R) is 15% of P.



Note

After calibration, it may be necessary to re-adjust the **PROPORTIONAL** and **DERIVATIVE** trimmers under normal working conditions.

If instability problems occur when a position controller is connected, recalculate the position loop parameters.

Speed offset

Use the following procedure to compensate for offset in **the Speed Reference** signal. This will cause the motor to be stopped when zero speed is demanded

Note

When using this procedure, Position control must be open loop.

1. Adjust the **Speed Reference** signal offset in the controller before connecting the controller to the Drive.
2. Connect the **Speed Reference** signal input to pins 7 and 8 of the signal input connector.
3. Check that any limit switches are not being actuated.
4. Enable the Drive and adjust the **ZERO OFFSET** potentiometer to stop the motor.
5. Restore the wiring to its original state.

Full-scale speed

When the **MAX SPEED** trimmer is set fully CCW the maximum motor speed is reduced to 75%. When fully CW the max motor speed is increased to 140%.

Set switch SW1/1 for the required full-speed.

ON = 3000 rpm (default)
OFF = 6000 rpm (applicable on high speed model only.)

Motor poles

Set switch SW3 for the number of motor poles.

No. of poles	SW3/1	SW3/2	
8	OFF	OFF	
6	OFF	ON	Default
4	ON	OFF	
2	ON	ON	

Limit switches

Set switch SW1/2 to enable or disable the limit switch function.

ON = Enabled
OFF = Disabled (default)

When the limit switch function is enabled (SW1/2 ON), set SW5 for direction of rotation.

SW5/1	
ON	CCW rotation is disabled when 0V is applied to the CCW limit switch pin.
OFF	CCW rotation is disabled when 0V is applied to the CCW limit switch pin or when the pin is open circuit (default).
SW5/2	
ON	CW rotation is disabled when 0V is applied to the CW limit switch pin.
OFF	CW rotation is disabled when 0V is applied to the CW limit switch pin or when the pin is open circuit (default).

Rated current

You may reduce the rated Drive current if it exceeds the rated motor current.

Refer to the following table for setting switches SW2/1 to SW2/4 to reduce the rated Drive current.

Model						
100 [A]	**200 [A]**	**300 [A]**	**SW 2/1**	**SW2 /2**	**SW 2/3**	**SW 2/4**
2.16	3.78	5.67	OFF	OFF	OFF	OFF
2.30	4.02	6.02	OFF	OFF	OFF	ON
2.43	4.25	6.38	OFF	OFF	ON	OFF
2.57	4.49	6.73	OFF	OFF	ON	ON
2.70	4.73	7.09	OFF	ON	OFF	OFF
2.84	4.96	7.44	OFF	ON	OFF	ON
2.97	5.20	7.80	OFF	ON	ON	OFF
3.11	5.43	8.15	OFF	ON	ON	ON
3.24	5.67	8.51	ON	OFF	OFF	OFF
3.38	5.91	8.86	ON	OFF	OFF	ON
3.51	6.14	9.21	ON	OFF	ON	OFF
3.65	6.38	9.57	ON	OFF	ON	ON
3.78	6.62	9.92	ON	ON	OFF	OFF
3.92	6.85	10.28	ON	ON	OFF	ON
4.05	7.09	10.63	ON	ON	ON	OFF
4.19	7.32	10.99	ON	ON	ON	ON

Simulated encoder resolution

Set SW4 for the required simulated encoder resolution.

Encoder step resolution	SW4/1	SW4/2	
1024	OFF	OFF	
512	OFF	ON	Default
256	ON	OFF	
128	ON	ON	

Range components

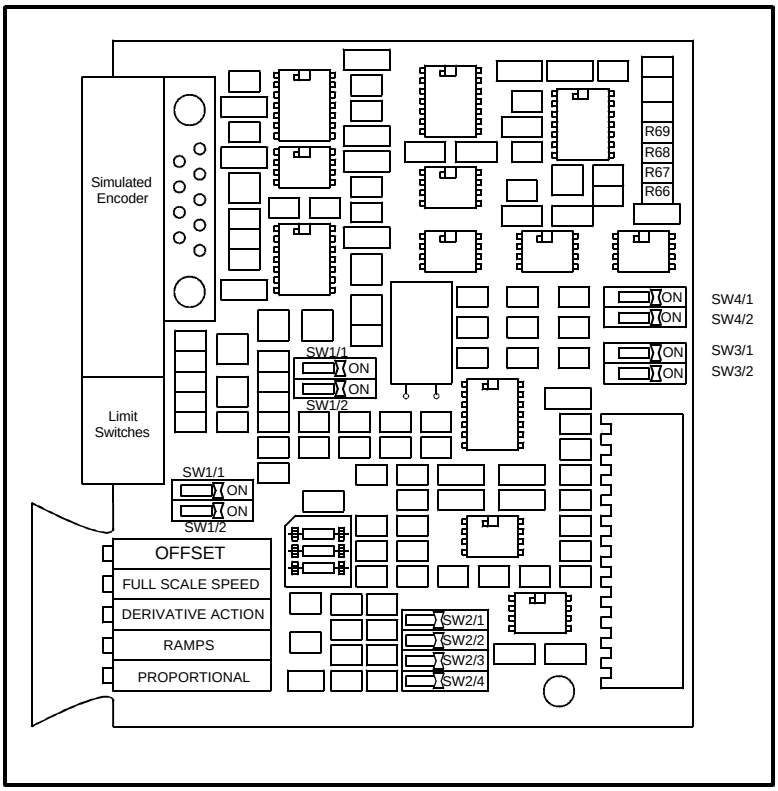
A component socket is located immediately behind the adjusting potentiometers on the Personality board. Three components can be fitted to this socket in order to modify the range of adjustment of the trimmers:

Component position	Type of component
Upper	Capacitor C11
Increases Derivative control	
Middle	Resistor (default value 82kΩ)
Adapts control loop to load inertia	
Lower	Capacitor C9
Increases Proportional control range	

Increase the resistor value for greater values of load inertia.

Final checks

Leave the system powered for at least 15 minutes in normal working conditions. Check the green LED remains continuously illuminated) and the red I^2t LED does not illuminate.



Locations of components on the Personality board

8 Diagnostics

LEDs on the front panel indicate the following:

Function	LED	When lit...
DRIVE NORMAL	green	Drive is functioning correctly. (When unlit, at least one fault is detected.)
Resolver break	red	
Fault in the resolver circuit, eg: Resolver break Short circuit in connection wiring Wrong connection Excitation signal not present To reset, remove and re-apply power.		
Heatsink over-temperature	red	Excessive heatsink temperature. No reset action required.
Motor over-temperature	red	Excessive motor temperature. No reset action required.
High Irms	red	
Current limiting due to I^2t exceeding the programmed value. Possible causes: Duty cycle having high and frequent acceleration Frequent direction reversal Undersized Drive When the red LED is lit, the Drive delivers the nominal current programmed using the SW2 switches. Current limiting is not a trip and the green LED remains lit. If the Drive is disabled when the red LED is lit, the conditions are maintained until the next enable command is issued.		
Clamp active	yellow	The LED lights when the braking resistor is in use.

Outputs on the signal connector can be used for remote monitoring and indicate the following:

Function	Type	Notes
Drive normal	Contacts	
When the green LED is lit, pins 9 and 10 are internally connected by contacts. When a fault is detected, the contacts open. These can be used to operate a remote control power switch.		
I^2t limiting	Open collector	Normally conducting (logic 0). Open-circuit when in I^2t limiting.

9 Fault finding

Green LED continuously extinguished

This shows at least one fault is detected

Check...

- Power supply voltage is not out of range
- Short-circuit between connector pins
- Wiring of the **OUTPUT** connector pins
- Braking resistor over-heated or burning. (Fit an external braking resistor or increase the power rating of existing external braking resistor —see Appendix A.)

If the fault persists when the signal connector is disconnected:

- If an external braking resistor is connected, check that the jumper between pins 27 and 28 has been removed.
- The value of the external braking resistor is not too low.

If the fault is present only when the Drive is operating:

- Acceleration/deceleration times are not too short
- Duty cycle is not too high

Green LED extinguishes when the Drive is enabled

Check...

- One wire of the motor cable is not grounded. To do this, remove the motor wiring from the **OUTPUT** connector. Enable the Drive. If the fault disappears, check the wiring.

If the **Speed Reference** input is not at zero when the Drive is enabled and the motor does not turn:

- Check the limit switch function is active and the switches operate.
- Disable the limit switch function using switch SW1/2
- Check the voltage on pins 43 and 45
- Check the position of DIP switches SW5/1 and SW5/2.

10 Special applications

Note

It may be necessary to open and modify the Drive. The modifications change the factory settings.

Caution

Modifications should be performed only by Control Techniques personnel.

Make a note on the Drive stating that it has been modified. This will help to avoid confusion. Installing a standard Drive instead of a modified one could damage the Drive.

External braking resistor

When the power rating of the internal braking resistor is inadequate, connect an external braking resistor having a higher power rating.

The internal braking resistor is internally connected between terminals 28 and 29 and is connected with an external wired jumper between pins 27 and 28.

The +DC bus is available on pin 27.

Procedure

1. Remove the jumper between pins 27 and 28
2. Connect an external braking resistor of not less than 33Ω between pins 27 and 29

Torque Mode applications

The Drive may be operated in Torque Mode using pin 2 (**TPRC**) for the **Current Reference** signal input. Pin 2 is a bi-directional input with a signal range between −10V and +10V. The motor direction follows the signal polarity. Maximum current is supplied when the reference signal is +10V or −10V.

Ensure that pins 7 and 8 are disconnected.

The output impedance of the **Current Reference** signal source must be ≤600Ω

Warning

If the Drive is operating in Torque Mode and the I·t limit is reached, the red LED illuminates and the output on pin 12 becomes 0V. No current limit is performed. This must be managed by the control system.

Output frequency resolution

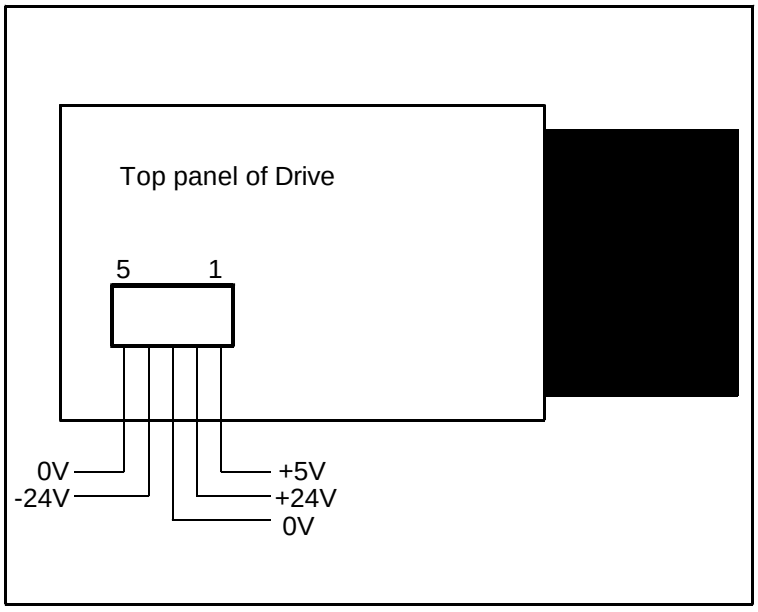
The **Frequency Output** is programmed in the factory for 256 pulses per revolution. By removing and fitting jumpers, the resolution of the frequency signal can be changed.

Since the jumpers are surface mount types requiring specialized tools for removing them, it is advised that the required locations are specified when ordering.

Pulses/revolution	Insert	Remove
2048	R66	R69
1024	R67	R69
512	R68	R69
256	R69	

Simulated encoder back-up supply

When a back-up supply is connected to the connector on the top of the case, the Drive is able to follow the incremental encoder signal when the bus is removed.



Location of the back-up supply connector

Back-up supply requirements

+8V	300mA
+24V	250mA
-24V	400mA

Note

If the Drive is connected to the back-up supply when the bus is removed, the DRIVE NORMAL **green** LED **is extinguished for about 2 seconds then lights again. The Status Relay follows the operation of the green** LED**. While back-up is in operation, the Drive is disabled, the green** LED **is lit and the Status Relay contacts are closed.**

A specially designed power supply is available for standard rail mounting. It requires an external 30 VA transformer with a secondary voltage of 18V when under load.

Single-phase bus

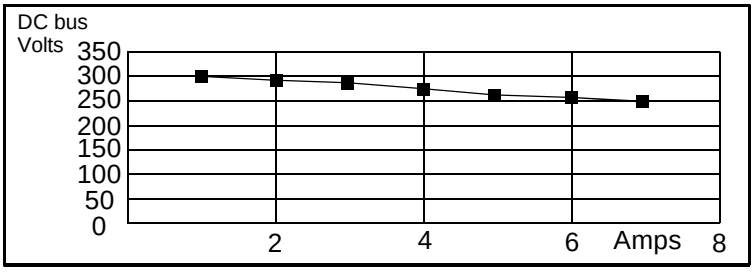
To use the Drive on single-phase bus, connect the supply to pins 30 and 31 of the **Power** connector. Calculate the required power rating of the transformer using the formula given for the three-phase transformer.

The nominal current ratings of the Drives when supplied by a single-phase supply are as follows:

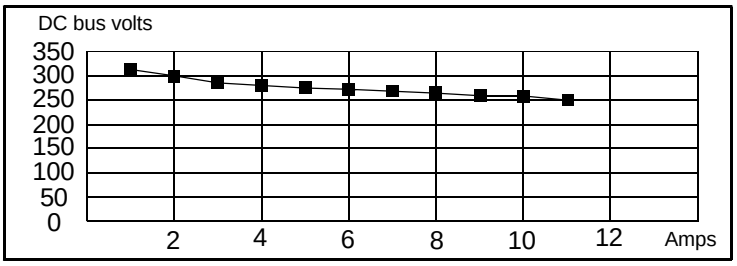
MaxAx 100	DC bus voltage derated by 15%
MaxAx 200	DC bus voltage derated by 15% but a third internal capacitor **must be** connected
MaxAx 300	DC bus voltage derated by 15% but a fourth external capacitor **must be** mounted

Adding a capacitor to the Drive ensures the minimum DC bus voltage is 265 V when the Drive is supplying its nominal current.

The following diagrams show how the DC bus voltage changes in relation to the current demand. Note that the maximum speed is related to the DC bus voltage level.



DC bus voltage in relation to current when two capacitors are used (MaxAx 100 and 200)



DC bus voltage in relation to current when three capacitors are used (MaxAx 300)

11 Re-phasing a resolver

Motors supplied by Control Techniques have the resolver mechanically phased with the motor rotor. If a motor of different manufacture is used or if a resolver has been removed from the motor, it is necessary to re-phase the resolver with the motor. To do this, use the following procedure:

1. Disconnect the load from the motor.
2. Disable the Drive.
3. Connect a jumper between pin 6 (−10V) and pin 14 (motor PTC).
4. Apply a **Speed Reference** signal to pin 7 (positive with reference to pin 8).
5. Set SW2 for nominal current (all switches at ON).
6. Enable the Drive.
7. The rotor turns to one of specified positions. The green LED under the daughter board lights.

   If the LED remains unlit, unscrew the resolver stator from the motor frame and turn it slowly until the green LED lights. Lock the resolver stator in this position.

12 Identifying motor phases

1. When the exact phase sequence in a motor is unknown, it is possible to identify the **U**, **V**, **W** phases using a current generator having isolated outputs of at least 2A capability, and a voltmeter.

2. Connect the 'positive' output of the current generator to a motor phase. Name this phase **U**.

3. Connect the 'negative' output to another phase. The motor turns to a new position.

4. Move the 'negative' output to the third motor phase and look at the motor shaft from its end. If the shaft turns CCW, name the phase connected to the negative terminal **W**. If the shaft turns CW, name the phase connected to the negative output of the generator **V**.

5. Connect the motor and resolver to the Drive.

6. Disable the Drive and turn the motor shaft CW by hand. Using the voltmeter, check the TACHO signal (tenths of millivolts) on pin 1. The signal should be a positive voltage referred to the signal common. If a negative voltage is detected, exchange the sine cable pair with the cosine cable pair.

7. Follow the procedure in Re-phasing a resolver above.

13 Encoder simulation

The encoder simulation signal is a differential output and the output device is a RS422 line driver.

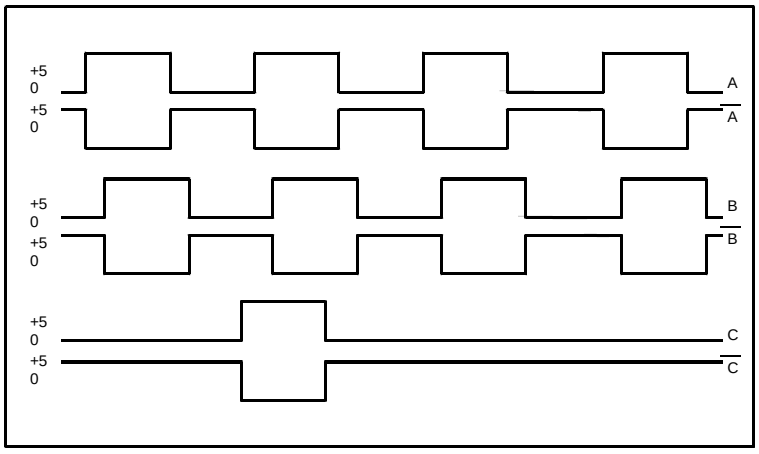
The signals are as follows:

Low	0V
High	+5V

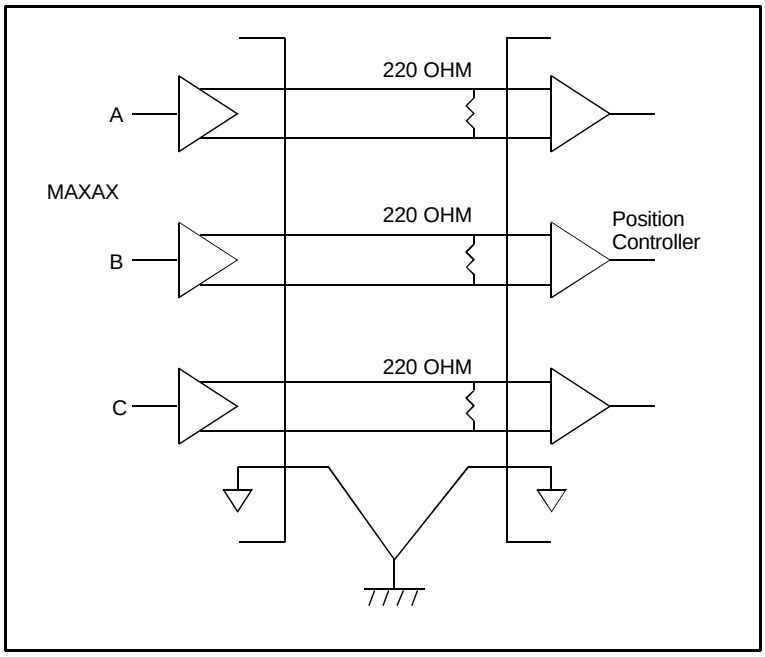
The signals should be be measured as follows:

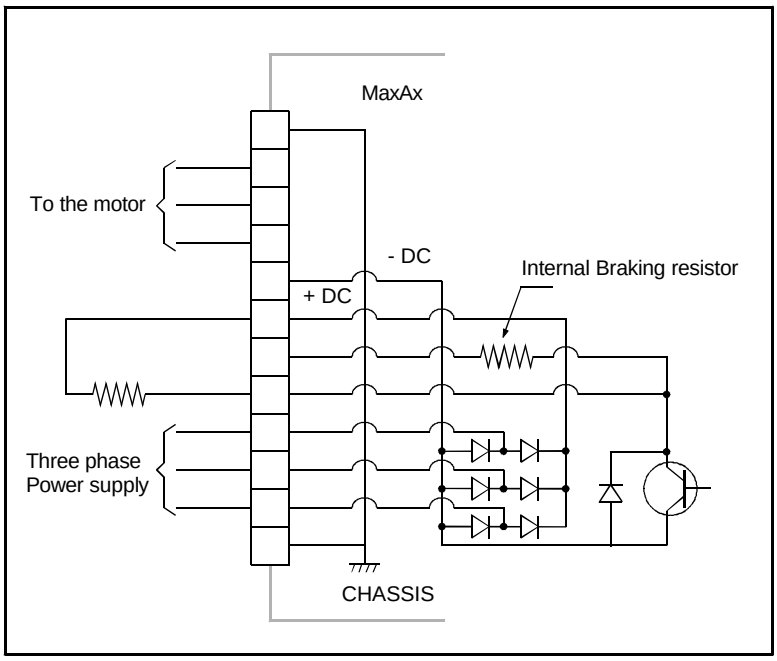
Between A and not-A
Between B and not-B
Between C and not-C

The phase shift between channel A and B is 90°. The C pulse is phased with the A pulse. See below.



Maximum driving capability is 20 mA. Each output may be connected to a maximum of ten line-receiver devices with a maximum cable length of 1200m (4000feet). To avoid standing waves, connect a 220Ω resistor in parallel with the most remote receiver.


220 OHM
A
MAXAX
220 OHM
Position
Controller
B
220 OHM
C


MaxAx
To the motor
- DC
Internal Braking resistor
+ DC
Three phase
Power supply
CHASSIS

14 External braking resistor

The resistor power rating should match the average dissipated power during deceleration. Use the following formula to calculate the required power rating:

$$P = 0.2 * J_t * \omega^2 * f$$

where:

P = power to be dissipated (in Watts)

$\mathbf{J_t}$ = total inertia (in kg m^2)

ω = max angular velocity (in rad/sec)

f = cycle repetition frequency (in number of cycles per second)